FINAL PROJECT REPORT

Project Title: Apple microbial risk factors

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Cooperators: Intertox Decision Sciences, LLC

Other funding sources

Agency Name: The Center for Produce Safety
Amt. awarded: $66,807
Notes:

Total Project Funding: $133,614

Budget History:

Item	2012	2013	2014
Salaries	17,698.62	20,370.60	
Benefits	8,141.38	9,667.44	
Wages			
Benefits			
Subcontract		1,850.00	
Shipping			
Supplies	254.45		
Travel	899.51		425.00
Expert Panel		7,500.00	
Miscellaneous			
Total	$26,993.96	$39,388.04	$425.00

Footnotes: The 2013 funded amount of $39,388.04 included a 2012 budget carryover of $9,129. Of the expended funds, $1,850 was spent on subcontractor data collection and analysis work, $7,500 was invoiced for Expert Panel member payments and the remainder was spent on salary and benefits. 2014 funds requested were $425 for travel to present the research results at the Northwest Horticultural Council Meeting in March 2014 and at the Center for Produce Safety Symposium in June 2014.

OBJECTIVES

This project had five objectives. As of December 31, 2014, all five objectives have been completed. The final objective was completed in January 2014. A review of the objectives and a discussion of the major findings are provided below.

1. **Gather pathogen testing data and information about mitigation measures from apple growers.**

   In early 2013, an industry survey was conducted that focused on food safety practices growers use to protect against microbial risks. Sixty-eight companies completed surveys. In the survey, growers were asked to identify their water sources, irrigation types and evaporative cooling details. For food safety practices, growers were asked to describe their sanitation and maintenance procedures and worker training. Finally, growers were asked about microbial testing types and frequencies.

2. **Correlate pathogen levels in water used in fresh market apple production and packing operations at different points in the system to levels measured on apples before they leave the packinghouse.**

   In addition to the water and microbial test data collected from testing laboratories, IDS collected packing line data consisting of pH, ORP, chlorine and temperature readings for various points along individual packing lines. Efforts were made to correlate the available data with environmental and product tests results.

3. **Characterize potential exposure to pathogens from consumption of fresh market apples and describe potential human health effects associated with these exposure levels; combine the results to estimate the risk of becoming ill from eating contaminated apples.**

   The exposure assessment was completed in 2013. The exposure assessment was combined with the hazard characterization in an apple-specific quantitative microbial risk assessment (QMRA) model and FDA-iRISK modeling tool to provide risk estimates for illness from eating contaminated apples.

4. **Prepare a written risk assessment report about the findings of Objectives 1-3.**

   A written risk assessment was completed in December 2013.

5. **Submit the risk assessment model and report for review to an advisory panel consisting of the WTFRC, the Northwest Horticultural Council and other experts in the field of quantitative microbiological risk assessment.**

   In December 2013, the risk assessment model and report were submitted to representatives from the WTFRC and the Northwest Horticultural Council (NHC) for review. After completion of the WTFRC and the NHC review, the risk assessment was submitted to an expert panel with whom a call was held in January 2014.

SIGNIFICANT FINDINGS

- No foodborne illness outbreaks associated with whole fresh apples were identified in either the CDC's FOOD database or in further Internet research.
- Research studies relating pathogens to apples were identified for *E. coli* O157:H7, *Salmonella*, and *Listeria monocytogenes* (*L. monocytogenes*). However, *Salmonella* and *L. monocytogenes* contamination risk assessments were ruled out at this time due to a lack of data and research related to the behavior of these pathogens on apples.
- In both the Intertox-developed risk assessment model and the FDA-iRISK® model, the risk of illness from *E. coli* O157:H7 is negligible for a given orchard treated with evaporative cooling water at *E. coli* levels found in Washington.

RESULTS & DISCUSSION

The major finding from this study is that the risk of *E. coli* O157:H7-related illness from the consumption of Washington apples following a water-related contamination event in the orchard (associated with evaporative cooling) is negligible. This conclusion was drawn after modeling Washington apple production and packing processes using available literature study data along with data collected from packinghouses and orchards. For the QMRA, a model was developed using Microsoft Excel and Palisade @Risk software to estimate potential exposure levels to these pathogens and the risk of becoming ill from eating contaminated fresh market apples. The model is based on potential contamination and growth/reduction of pathogens occurring in the field, during cooling, storage and packing. The model estimates exposures for adults children, pregnant women and the elderly using national fresh apple consumption rates, and incorporates probabilistic methods to characterize the uncertainty and variability in model inputs as well as outputs (e.g., where possible, input parameters such as temperature, time, etc., are included). Risks are characterized as the probability illness along with the total estimated number of cases. In addition to using the Intertox model, the risk of illness was also assessed using the FDA-iRISK® modeling tool in the same manner as the FDA used this tool to assess the risk of illness from consuming contaminated leafy greens. As in the Intertox model, the FDA-iRISK® model characterized the probability of illness along with the total estimated number of cases. While results from both models are comparable, the Intertox model included parameters that had greater specificity for apples.

As part of the QMRA process, data limitations and needs for further research were identified. In several cases, assumptions regarding pathogen growth and decrease were drawn from studies that may not reflect conditions consistent with commercial packing, (e.g., sanitizer concentrations, available nutrients, characteristics of the apple variety). Studies estimating pathogen growth and decrease in fresh market apples are also extremely limited. Even with the data limitations, however, this study is of value. The QMRA provides a baseline estimate of risk for the industry and indicates where further research efforts are needed.

EXECUTIVE SUMMARY

A quantitative microbial risk assessment (QMRA) model was developed using data from industry and scientific research in order to estimate risk of illness from the consumption of fresh market apples. The model can be used by the industry to predict apple pathogen levels from the orchard through departure from the packinghouse, using various contamination scenarios. The model currently provides an initial risk estimate for consumption of apples that have been contaminated by pathogenic *Escherichia coli* (*E. coli*) in evaporative cooling water applied to apples in the orchard prior to harvest. The QMRA model estimates the potential for change in apple pathogen levels during various stages of primary production and packing using relevant orchard, storage, and packing facility parameters. Based on the results, preventive measures should be in place during production to minimize the potential for apple contamination.